

USING THE ROOTS METER TO CALIBRATE FLOW CALIBRATORS

Purpose This Meteorology and Air Quality Group (MAQ) procedure describes the steps for using the Roots Meter to calibrate hi-volume calibrators and AIRNET flow calibrators.

Scope This procedure applies to the individuals assigned to calibrate the portable calibrators with the Roots meter.

In this procedure This procedure addresses the following major topics:

Topic	See Page
General Information About This Procedure	2
Who Requires Training to This Procedure?	2
Background and Worker Safety	4
Determining Flow Through Roots Meter	5
Calibration	7
Records Resulting from This Procedure	9

Hazard Control Plan The hazard evaluation associated with this work is documented in Attachment 1: Initial risk = **low**. Residual risk = **minimal**. Work permits required: none. First authorization review date is one year from group leader signature below; subsequent authorizations are on file in group office.

Signatures

Prepared by: _____ Alice Baumann, MAQ	Date: <u>9/25/2003</u>
Approved by: _____ Craig Eberhart, Environmental Air Monitoring Project Leader	Date: <u>9/29/2003</u>
Approved by: _____ Terry Morgan, QA Officer	Date: <u>9/30/2003</u>
Work authorized by: _____ Jean Dewart, MAQ Group Leader	Date: <u>10/17/2003</u>

10/20/2003

CONTROLLED DOCUMENT

This copy is uncontrolled if no red stamp is present on printed copies. Users are responsible for ensuring they work to the latest approved revision.

General information about this procedure

Attachments This procedure has the following attachments:

Number	Attachment Title	No. of pages
1	Hazard Control Plan	2
2	Calibration Using the Roots Meter	1

History of revision This table lists the revision history and effective dates of this procedure.

Revision	Date	Description Of Changes
0	8/13/03	New document.
1	10/21/03	Added chapter on calibrating AIRNET flow calibrators.

Who requires training to this procedure? The following personnel require training before implementing this procedure:

- Personnel assigned to operate the Roots meter to calibrate Hi-Vol calibrators or AIRNET calibrators.

Training method The training method for this procedure is **on-the-job** training by a previously-trained individual and is documented in accordance with the procedure for training (MAQ-024).

Prerequisites In addition to training to this procedure, the following training is also required prior to performing this procedure:

- MAQ-011, "Logbook Use and Control"
- First Aid
- Cardiopulmonary Resuscitation (CPR)

General information, continued

Definitions specific to this procedure

Roots Meter: a non-adjustable positive displacement unit designed to accurately measure the actual volume of gases and gas mixtures, regardless of barometric pressure or temperature.

References

The following documents are referenced in this procedure:

- MAQ-011, “Logbook Use and Control”
 - MAQ-024, “Personnel Training”
 - MAQ-224, “Air Sampling for Particulate Mass Using the Volumetric Air Samplers”
 - MAQ-240, “Operating the CF-1000BRL High Volume Samplers”
-

Note

Actions specified within this procedure, unless preceded with “should” or “may,” are to be considered mandatory guidance (i.e., “shall”).

Background and worker safety

Background The need for a system to accurately calibrate air flow calibrators to read actual flow at Los Alamos County altitude was discovered during evaluation of flow calibration standards (see MAQ deficiency report 411). Actual flow on a high-volume sampler was determined using the Roots meter. Three Hi-Q calibrators were then placed on the unit. The readings varied significantly among the calibrators.

Description of devices Both types of calibrators work on a similar principle. The calibrators consist of an orifice with a vacuum gauge connected across the orifice. The pressure drop across the orifice is proportional to the flow rate. The scale on the vacuum gauge is marked to indicate the actual flow rate, as measured by the Roots meter.

The TSP (Hi-Volume) samplers have a variable-speed motor and a “floating ball” type meter to indicate the flow rate.

Maintenance The Roots meter is generally maintenance-free. Ensure there is oil in the gearhouse (see manual) and keep plastic covers in place when not in use.

Calibration of Roots meter Ship Roots meter to originating company or to American Meter Company for calibration every 2 years.

NOTE: Calibration of the Roots meter using a bell prover requires a 100 cubic foot bell. The bell in the Cave is 5 cubic feet.

Performing work safely **DO NOT perform work under conditions you consider unsafe.** Before beginning work described in this procedure, review safety needs and requirements, identify hazards, and develop hazard mitigation measures. Be aware that facility configurations and hazards may change between visits.

Contact your supervisor and the project leader if working conditions are found to be unsafe.

Calibrating the Hi-Vol calibrators

Frequency of calibration	Perform the steps in this chapter to calibrate the orifice-type hi-volume calibrators every two years.
Checking the original scale	Perform the steps below with the original scale in place to see if the calibrator is already “calibrated.” If the scale reads correctly or can be adjusted, it is not necessary to make a blank scale for marking.
Prepare blank scale for calibration	If the original scale is not correctly indicating the calculated flows (see block immediately above), remove the gauge face cover from the vacuum gauge. Fabricate a blank scale plate to be marked with the flow rates and perform the steps below to create a new calibrated scale.
Steps to calibrate the calibrator	To calibrate a hi-volume air flow calibrator, perform the following steps:

Step	Action
1	Set up a Hi-Volume TSP sampler with an adjustable flow meter and remove the hood. Turn on the TSP.
2	Set the flow rate so the flowmeter reads 40 CFM and warm up motor for at least 5 minutes.
3	Ensure the Roots meter is attached to the custom base plate. Mount Roots meter on sampler using mounting rails and the four corner knurled nuts. CAUTION: Use proper lifting techniques to move the heavy Roots meter, or get a second person to assist.
4	Determine flow through the Roots meter following directions in chapter <i>Determining flow through Roots meter</i> .
5	Adjust TSP sampler speed so flow through Roots meter is about 40 CFM.
6	Obtain a manometer reading of the pressure differential on the Roots meter. Expected readings are not more than 0.4 in. water.
7	For the 40 CFM flow rate only: Adjust the flowmeter on the TSP to read the same as the calculated Roots meter flow rate. Adjustment screw is behind the panel on top of the flowmeter.
8	Remove the Roots meter, and replace with the calibrator (front face of gauge removed, blank scale plate installed).
9	Re-adjust the flow rate control knob so the flowmeter on the TSP reads the same as the calculated flow rate through the Roots meter.

Steps continued on next page.

Calibrating the calibrators, continued

Step	Action
10	If the original scale is being checked, determine if it reads correctly at the calculated flow rate. Turn the calibration adjustment screw to make the scale read correctly. Perform a flow check at other scale points to verify the calibration of the scale. If a new scale is being created, mark the scale plate with a line where the needle resides at the calculated flow rate.
11	Remove the calibrator and repeat Steps 3-4 and 8-9 adjusting the Roots meter indicated flow in 5 CFM increments from 20 - 50 CFM to create a new scale on the gauge (or confirm the readings on the original scale). The flowmeter on the TSP is no longer adjusted and is only used as a rough guide to set flow for Roots meter.
12	Add "ACFM" and the calibrator's serial number to scale plate and replace face cover.
13	Copy all logged data from the logbook and submit the copies to the Records Coordinator as calibration sheets.
14	Place a calibration sticker on the calibrator.

Calibrating the AIRNET calibrators

Frequency of calibration Perform the steps in this chapter to calibrate the AIRNET flow calibrators (manufactured by SAIC Radeco) every two years.

Steps to calibrate the calibrator To calibrate an AIRNET air flow calibrator, perform the following steps:

Step	Action
1	Set up the following equipment in order, with suitable hoses between each: <ul style="list-style-type: none"> • Roots meter • flow calibrator (to be calibrated) • flow control valve • AIRNET pump (intake side) CAUTION: Use proper lifting techniques to move the heavy Roots meter, or get a second person to assist.
2	With hose from Roots meter <u>disconnected</u> , start pump and adjust valve to obtain flow of 4.0 CFM on flow meter to be calibrated.
3	Connect hose to Roots meter.
4	Determine flow through the Roots meter following directions in chapter <i>Determining flow through Roots meter</i> . Record all data on the form “Calibration Using the Roots Meter” (Attachment 2) or in an equivalent format in a logbook.
5	For 4.0 CFM flow only: If the calculated flow is not the same as the indicated flow, adjust the flow meter so that it reads the calculated flow when the pump is running.
6	As a check of the linearity of the calibration, repeat steps 2 through 4 (not step 5) for indicated flows at 2.0, 3.0, 5.0, and 5.5 CFM. Additional flow values may be used if desired. If the calibrator is not linear (i.e., it reads correctly one point but is off by more than about 0.2 CFM at other flow rates), clean the lines and re-test. If linearity cannot be achieved, replace the meter.
7	Copy all logged data from the logbook, or copy the form, and submit to the Records Coordinator as calibration sheets.
8	Place a calibration sticker on the calibrator.

Determining flow through Roots meter

Determining flow rate with Roots meter

Follow the steps in this chapter to determine the flow rate from the Roots meter when it is used to measure the flow during the calibration steps in the previous chapters.

Steps to determine Roots flow

Follow these steps to determine the flow through the Roots Meter:

Step	Action
1	Note the beginning Roots meter reading at the instant the stopwatch is started. Allow to run for 5 minutes or more.
2	Note the ending Roots meter reading the instant the stopwatch is stopped. Record the run time in minutes, seconds, and tenths of a second.
3	Convert run time to minutes and hundredths of a minute. Example: 5 minutes, 36.6 seconds = 5 minutes + (36.6sec ÷ 60 sec-min ⁻¹) = 5.61 minutes.
4	Subtract the beginning meter reading from the end meter reading to obtain total cubic feet of air. Divide the total cubic feet of air by the minutes to calculate CFM.
5	Repeat steps 1 - 4. The two flow rates should be very close – no more than 2% different. Average the two readings. Use this calculated flow rate in the steps in the previous chapter.
6	Record all data and calculations on the form “Calibration Using the Roots Meter” (Attachment 2) or in an equivalent format in a logbook. Note the identification numbers of the calibrators and the Roots meter. Make entries in accordance with procedure MAQ-011.

Records resulting from this procedure

Records

The following records generated as a result of this procedure are to be submitted **within 3 weeks** as records to the records coordinator

- Entries in Logbook (made in accordance with MAQ-011)
- Copies of logbook pages showing calibration calculations

HAZARD CONTROL PLAN

1. The work to be performed is described in this procedure.

“Using the Roots Meter to Calibrate the Hi-Vol Calibrators”

2. Describe potential hazards associated with the work (use continuation page if needed).

Lifting Injuries -- lifting Roots Meter which weighs about 30 pounds.

Abrasions and bruises -- from moving and handling equipment.

3. For each hazard, list the likelihood and severity, and the resulting initial risk level (before any work controls are applied, as determined according to LIR300-00-01, section 7.2)

Abrasions /bruises — occasional / negligible = minimal

Lifting Injuries--lifting pumps and housings –Occasional / moderate = low

Overall *initial* risk: ☐ Minimal ☒ Low ☐ Medium ☐ High

4. Applicable Laboratory, facility, or activity operational requirements directly related to the work:

☒ None ☐ List:

Work Permits required? ☒ No ☐ List:

HAZARD CONTROL PLAN, continued

5. Describe how the hazards listed above will be mitigated (e.g., safety equipment, administrative controls, etc.):

Abrasions/bruises from moving pumps and materials -- Use common sense to avoid these injuries; also covered under Employee Orientation training

Lifting Injuries -- lifting pumps and housings -- training in proper lifting techniques.

6. Knowledge, skills, abilities, and training necessary to safely perform this work (check one or both):



Group-level orientation (per MAQ-032) and training to this procedure.



Other → See training prerequisites on procedure page 3. Any additional describe here:

7. Any wastes and/or residual materials? (check one) ☒ None ☐ List:

8. Considering the administrative and engineering controls to be used, the *residual* risk level (as determined according to LIR300-00-01, section 7.3.3) is (check one):



Minimal



Low



Medium (requires approval by Division Director)

9. Emergency actions to take in event of control failures or abnormal operation (check one):



None



List:

For all injuries, provide first aid and see that injured person is taken to Occupation Medicine (only if immediate medical attention is not required) or the hospital. For any exposed, energized electrical wires, contact JCNNM or the appropriate authority to turn off the power.

Signature of preparer of this HCP: This HCP was prepared by a knowledgeable individual and reviewed in accordance with requirements in LIR 300-00-01 and LIR 300-00-02.

Preparer(s) signature(s)

Name(s) (print)

/Position

Date

Signature by group leader on procedure title page signifies authorization to perform work for personnel properly trained to this procedure. This authorization will be renewed annually and documented in MAQ records.

Controlled copies are considered authorized. Work will be performed to controlled copies only. This plan and procedure will be revised according to MAQ-022 and distributed according to MAQ-030.

This form is from MAQ-254

[illegible]